DoD High Level Architecture for Simulation

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DoD M&S Master Plan Objective 1-1

- **Objective 1-1. Establish a common high-level simulation architecture to facilitate the interoperability of all types of models and simulations among themselves and with C4I systems, as well as to facilitate the reuse of M&S components.**
  - Simulations developed for particular DoD Components or Functional Areas must conform to the High Level Architecture
  - Further definition and detailed implementation of specific simulation system architectures remain the responsibility of the developing Component

The Common Technical Framework, and specifically the High Level Architecture, represents the highest priority effort within the DoD modeling and simulation community.
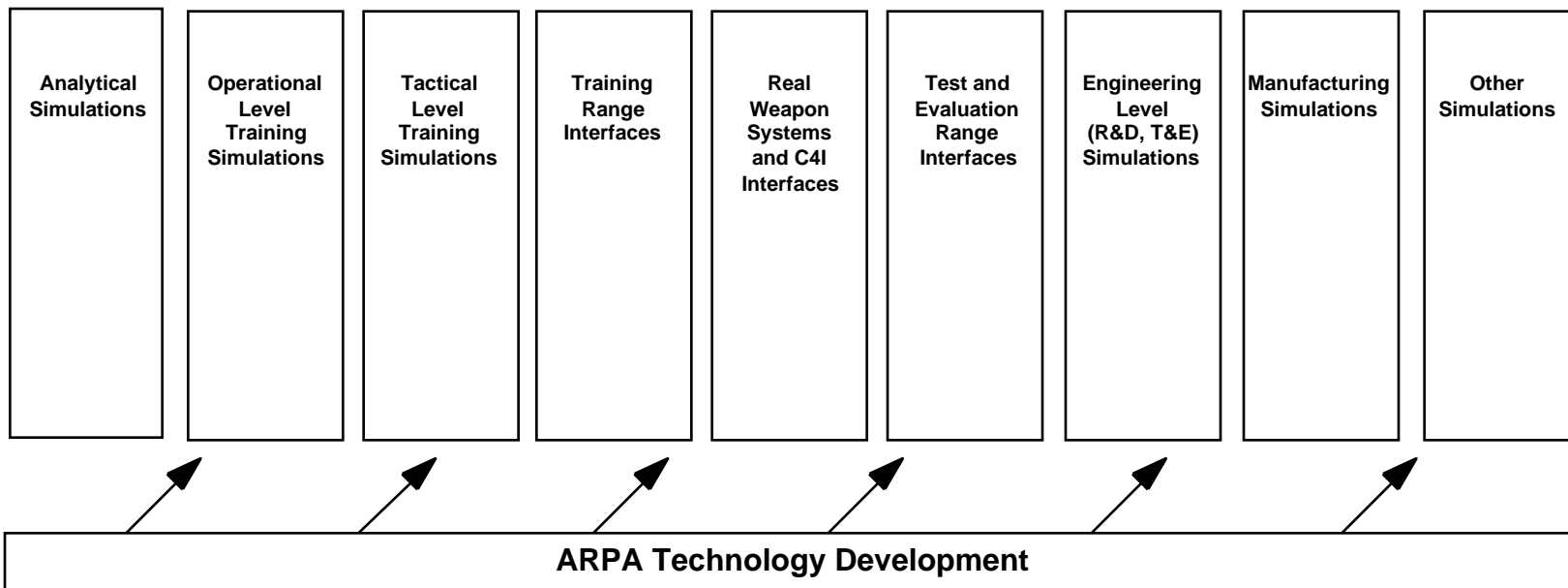
An Overarching Technical Framework

Master Plan's Technical Framework
High Level Architecture, Conceptual Models Of the Mission Space, Data Standardization

Domain-specific aspects

Analytical Simulations	Operational Level Training Simulations	Tactical Level Training Simulations	Training Range Interfaces	Real Weapon Systems and C4I Interfaces	Test and Evaluation Range Interfaces	Engineering Level (R&D, T&E) Simulations	Manufacturing Simulations	Other Simulations

ARPA Technology Development

High Level Architecture

Major functional elements, interfaces, and design rules, pertaining as feasible to all DoD simulation applications, and providing a common framework within which specific system architectures can be defined

Why HLA Now?

- **DoD M&S Vision**

   " ...common use of these environments will promote a closer interaction between the operations and acquisition communities in carrying out their respective responsibilities. To allow maximum utility and flexibility, these modeling and simulation environments will be constructed from affordable, reusable components interoperating through an open systems architecture."

- **DoD embarking on development of new generation of simulations**

- **Current technology (e.g., ALSP and DIS) does not provide tools necessary to achieve DoD M&S Vision**

Scope of HLA

- **Applicable to broad range of functional areas (e.g., training, contingency planning, analysis, and acquisition)**

- **Applicable to simulations involving pure software representations, man-in-the-loop simulators, and interfaces to live components (e.g., instrumented-weapon systems and C3 systems)**
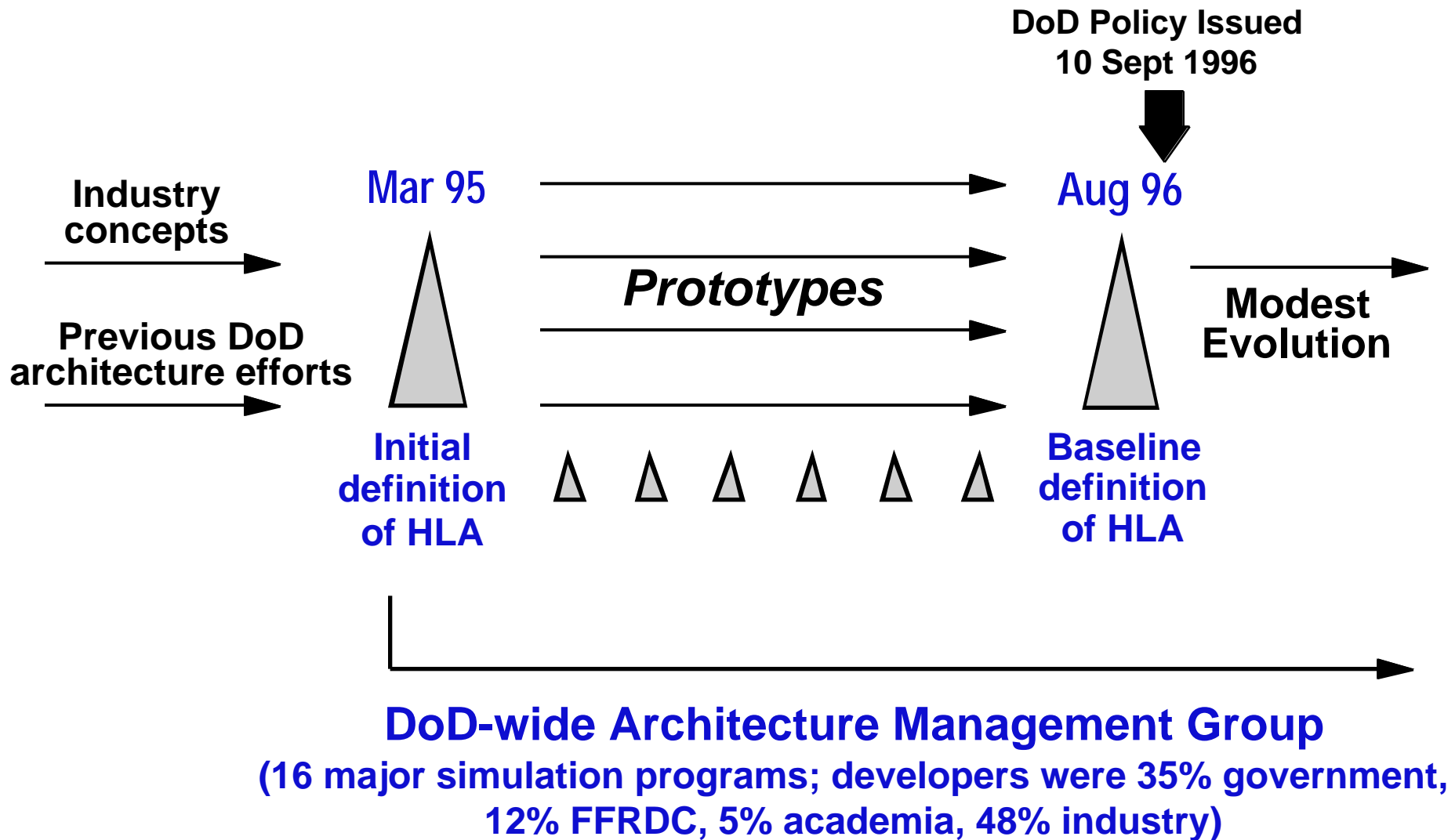
Role of HLA

- **Used by simulation system developers and policy makers**

- **Provides systematic and consistent basis for addressing simulation system design and implementation issues**
  - Many difficult issues still need to be resolved at system level – e.g., mechanisms for scalability, aggregation-disaggregation

- **Facilitates interoperability and reuse through a set of commonly applicable rules**

- **Furnishes framework for making policy decisions (e.g., imposition of specific standards)**

HLA Development Process Overview

**DoD Policy Issued
10 Sept 1996**

Industry concepts

Previous DoD architecture efforts

Mar 95 ──────────────────────────► Aug 96

Prototypes

Modest Evolution

Initial definition of HLA

Baseline definition of HLA

DoD-wide Architecture Management Group
**(16 major simulation programs; developers were 35% government,
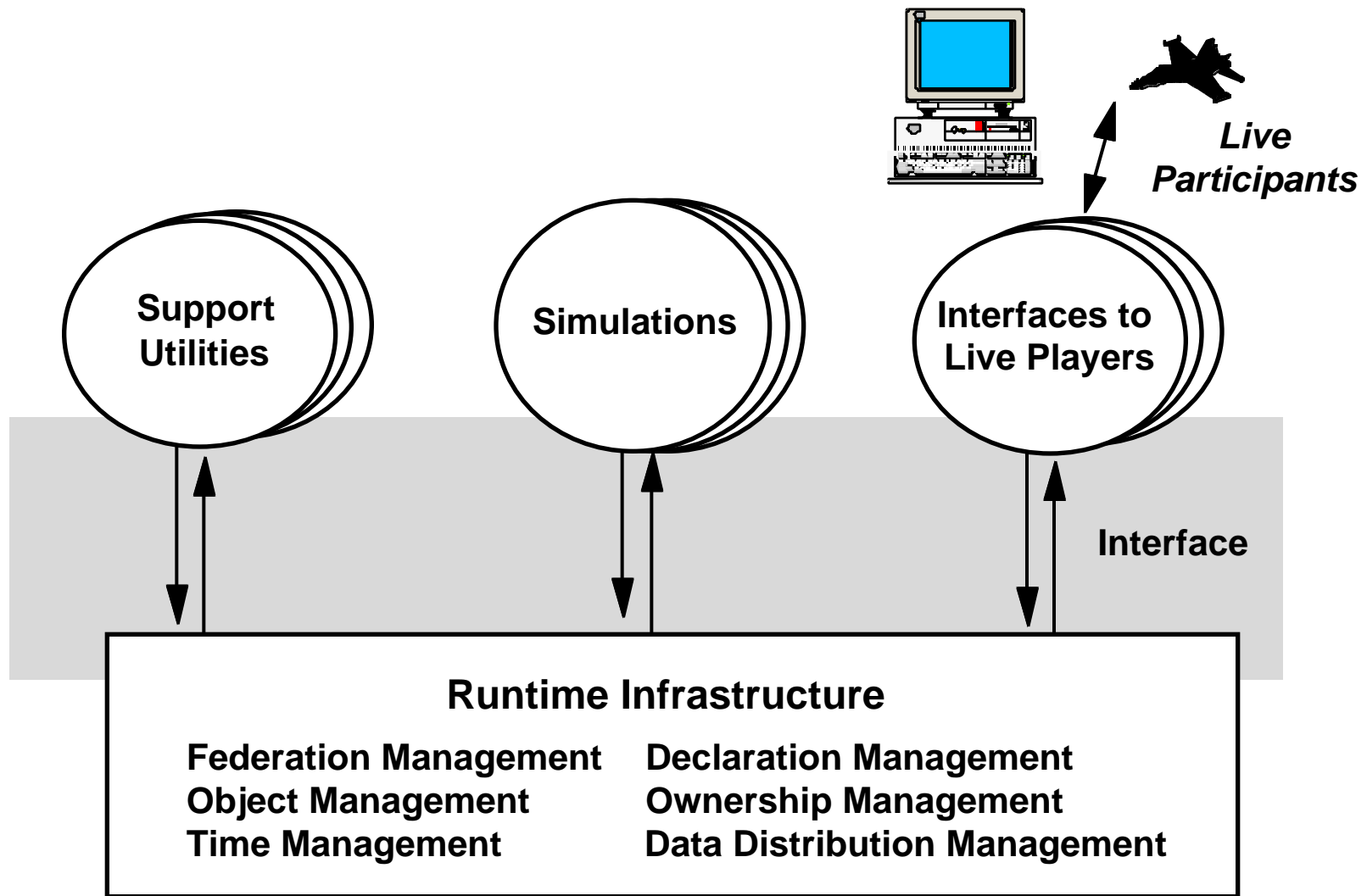12% FFRDC, 5% academia, 48% industry)**

Rationale for HLA Design

- **Basic premises:**
  - No single, monolithic simulation can satisfy the needs of all users
  - All uses of simulations and useful ways of combining them cannot be anticipated in advance
  - Future technological capabilities and a variety of operating configurations must be accommodated

- *Consequence:* Need <u>composable</u> approach to constructing simulation federations

- *Resulting design principles:*
  - Federations of simulations constructed from modular components with well-defined functionality and interfaces
  - Specific simulation functionality separated from general purpose supporting runtime infrastructure

Functional View of the Architecture

Live Participants

Support Utilities

Simulations

Interfaces to Live Players

Interface

Runtime Infrastructure

Federation Management
Object Management
Time Management

Declaration Management
Ownership Management
Data Distribution Management

Defining the HLA

- **HLA Rules.** A set of rules which must be followed to achieve proper interaction of federates during a federation execution. These describe the responsibilities of federates and of the runtime infrastructure in HLA federations

- **Interface Specification.** Definition of the interface services between the runtime infrastructure and the federates subject to the HLA

- **Object Model Template.** The prescribed common method for recording the information contained in the required HLA Object Model for each federation and federate

Federation Rules

1   Federations shall have an HLA Federation Object Model (FOM), documented in accordance with the HLA Object Model Template (OMT).

2   In a federation, all representation of objects in the FOM shall be in the federates, not in the runtime infrastructure (RTI).

3   During a federation execution, all exchange of FOM data among federates shall occur via the RTI.

4   During a federation execution, federates shall interact with the runtime infrastructure (RTI) in accordance with the HLA interface specification.

5   During a federation execution, an attribute of an instance of an object shall be owned by only one federate at any given time.

Federate Rules

6   Federates shall have an HLA Simulation Object Model (SOM), documented in accordance with the HLA Object Model Template (OMT).

7   Federates shall be able to update and/or reflect any attributes of objects in their SOM and send and/or receive SOM object interactions externally, as specified in their SOM.

8   Federates shall be able to transfer and/or accept ownership of attributes dynamically during a federation execution, as specified in their SOM.

9   Federates shall be able to vary the conditions (e.g., thresholds) under which they provide updates of attributes of objects, as specified in their SOM.

10 Federates shall be able to manage local time in a way which will allow them to coordinate data exchange with other members of a federation.

HLA Object Models

- **Object models describe:**
  - The set of shared objects chosen to represent the real world for a planned simulation or a federation
  - The attributes, associations, and interactions of these objects
  - The level of detail at which these objects represent the real world, including spatial and temporal resolution
  - The key models and algorithms used in representing the objects

- **The HLA will provide a template to characterize the object models**
  - Object Model Template (OMT) specification

HLA Object Models and Object Model Template

- **Object Model Template (OMT)**
  - Provides a common framework for HLA object model documentation
  - Fosters interoperability and reuse of simulations and simulation components via the specification of a common representational framework

- **Federation Object Model (FOM)**
  - A description of all shared information (objects, attributes, associations, and interactions) essential to a particular federation

- **Simulation Object Model (SOM)**
  - Describes objects, attributes and interactions in a particular simulation which *can* be used externally in a federation
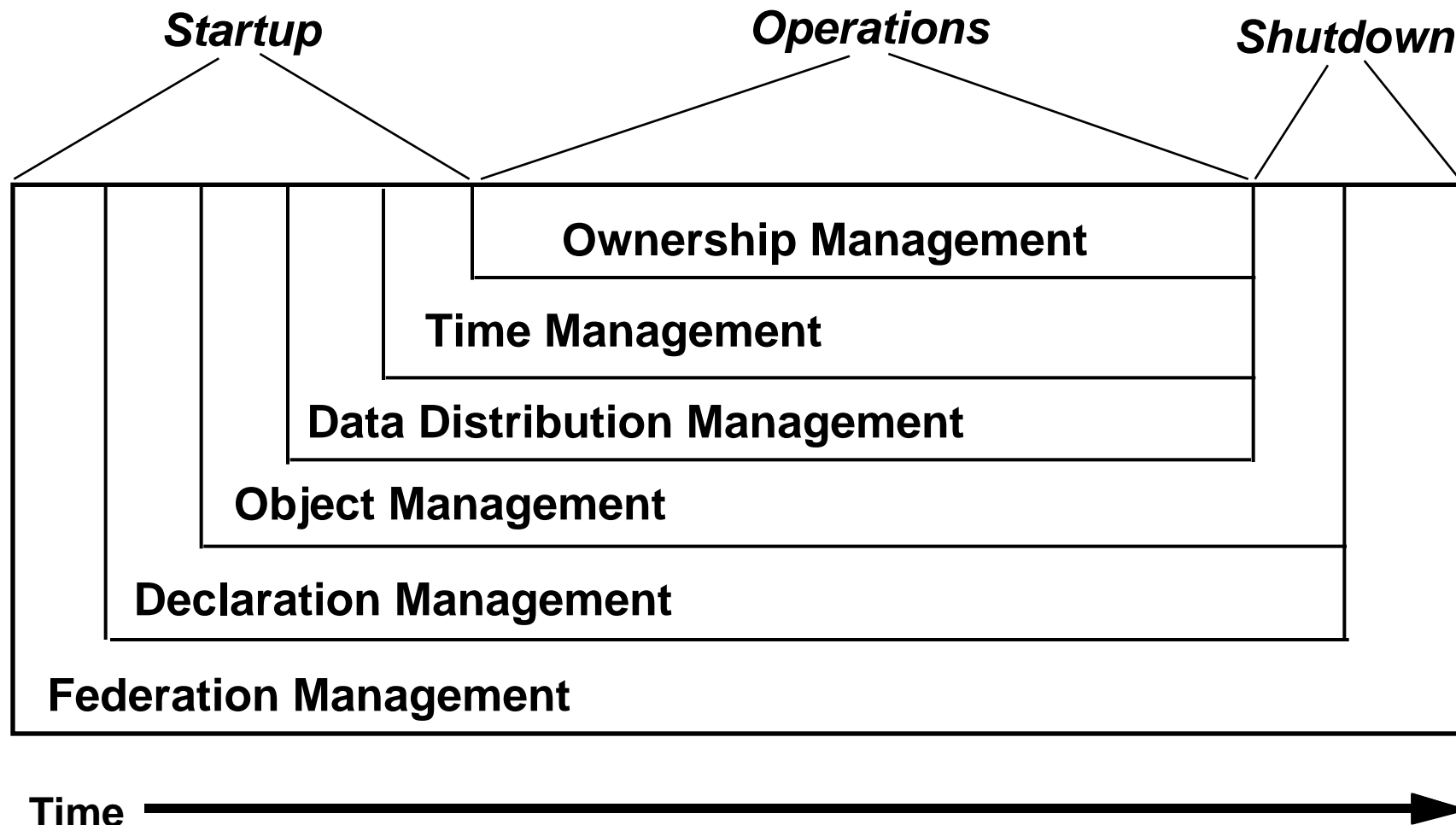
HLA Interface Specification

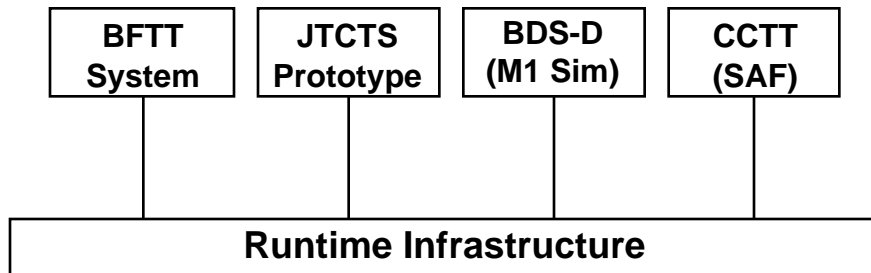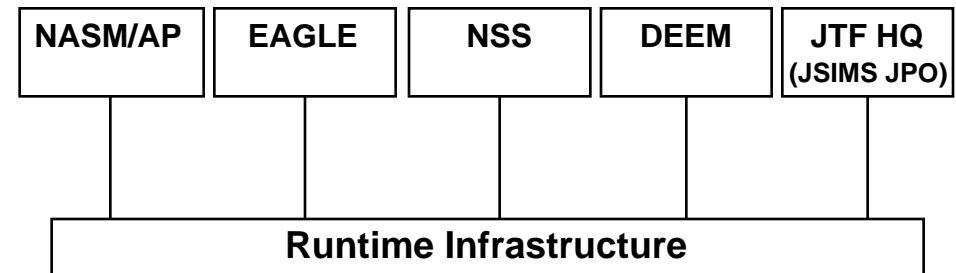| Category	Functionality
Federation Management	Create and delete federation executions Join and resign federation executions Control checkpoint, pause, resume, restart
Declaration Management	Establish intent to publish and subscribe to object attributes and interactions
Object Management	Create and delete object instances Control attribute and interaction publication Create and delete object reflections
Ownership Management	Transfer ownership of object attributes
Time Management	Coordinate the advance of logical time and its relationship to real time
Data Distribution Management	Supports efficient routing of data

HLA RTI Services over the Life of a Federation

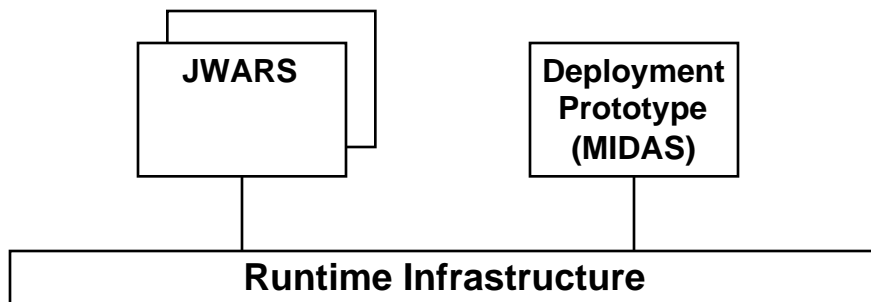**Startup**   **Operations**   **Shutdown**

Ownership Management

Time Management

Data Distribution Management

Object Management

Declaration Management

Federation Management

Time →

HLA Prototype Federations

Platform Federation

BFTT System	JTCTS Prototype	BDS-D (M1 Sim)	CCTT (SAF)

Runtime Infrastructure

Joint Training Federation

NASM/AP	EAGLE	NSS	DEEM	JTF HQ (JSIMS JPO)

Runtime Infrastructure

Analysis Federation

JWARS

Deployment Prototype (MIDAS)

Runtime Infrastructure

Engineering Federation

AFEWES	ACETEF	REDCAP	IADS	SBD	JMASS

Runtime Infrastructure

T&E EW
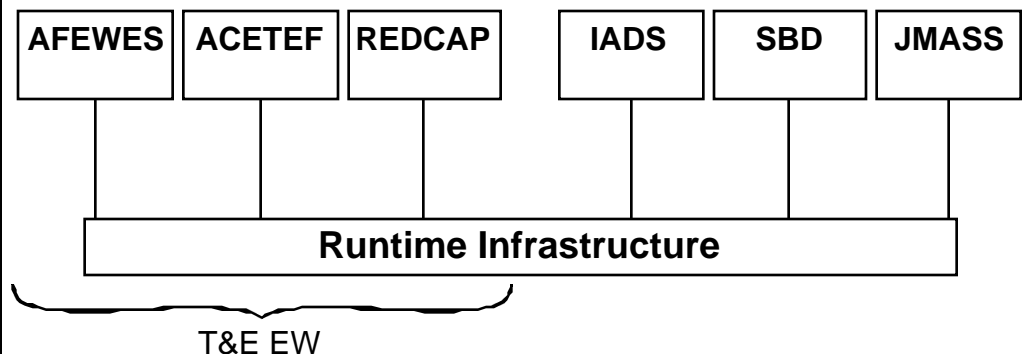
HLA Supporting Software

- **DMSO is sponsoring development of several software applications/tools which facilitate HLA use**
  - Runtime Infrastructure
    - FFRDC-developed 1.0 series (FAM Version now)
    - Commercially procured 2.0 series (Spring 98)
  - Object model development tools
  - HLA compliance testing tool
  - others TBD

- **Will be provided as shareware**
  - Have approval for international release of RTI

HLA Technical Library

- **DMSO has established an online "public library" for the M&S community, available through the DMSO Web page**

- **Contents**
  - **HLA Baseline Definition (Rules, Interface Specification, Object Model Template)**
  - **HLA Glossary**
  - **Interface Specification Supporting Documents (Test Procedures, Time Management, API)**
  - **OMT Supporting Documents (OMT Extensions, Test Procedures)**
  - **HLA Compliance Checklist**
  - **HLA Federation Development Process Model**
  - **HLA Security Architecture**
  - **Additional briefings and documents**

On-Line Documentation

- **Proceedings and products of the AMG appear under the subtopic "Common Technical Framework for M&S", under "High Level Architecture". DMSO home page site is:**

  - **http://www.dmso.mil/**

- **Specific questions can be directly addressed to DMSO via electronic mail at**

  - **hla@msis.dmso.mil**

Benefits of HLA Use

- **New capabilities (ownership transfer, smarter data distribution, etc.)**

- **Individual simulations and tools can be used by the large set of other HLA users**
  - Larger markets and bigger return on investment

- **Same infrastructure and interfaces can be used for a wide variety of simulation applications**
  - Large and small
  - Real-time and managed time
  - Local and distributed

- **Simulation developer doesn't need to invest in infrastructure**

- **Applications benefit from improvements in infrastructure technologies without having to pay for them**
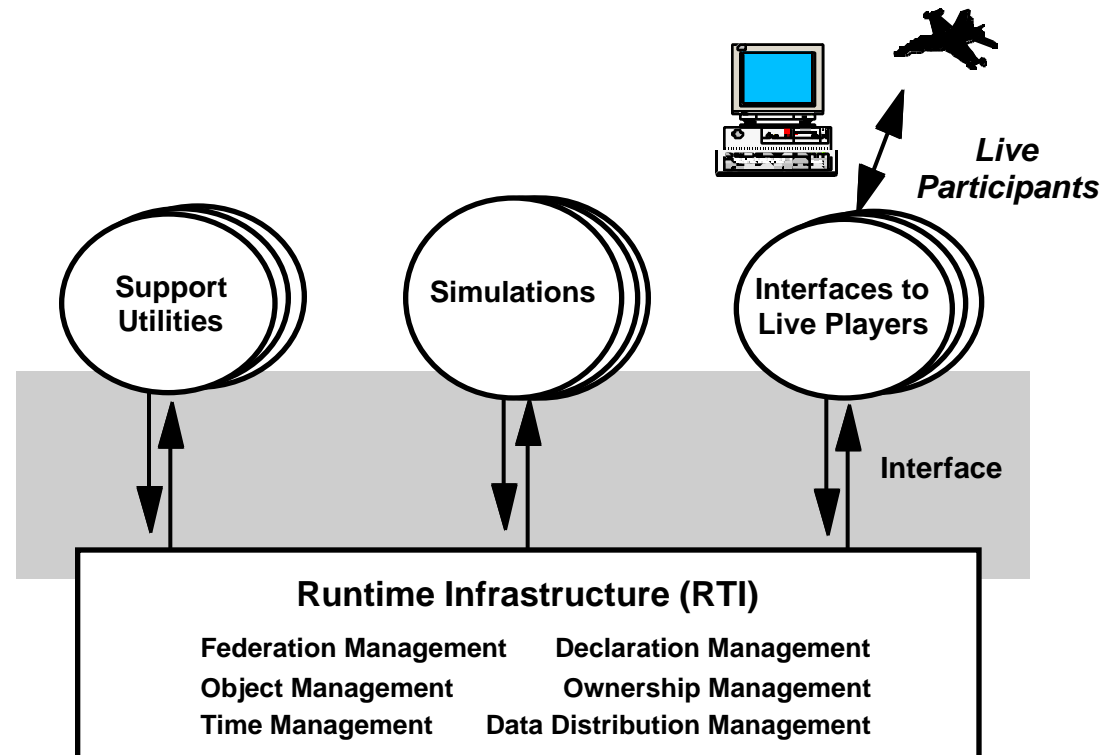 - Improved performance infrastructure can be inserted without an impact on applications

Backup

The High Level Architecture (HLA)

- ## Architecture calls for a federation of simulations

- ## Architecture specifies
  - ### Ten rules
    - define relationships among federation components
  - ### Object Model Template
    - specifies the form in which simulation elements are described
  - ### Runtime Interface Specification
    - describes the ways simulations interact during an operation

Live Participants

Support Utilities

Simulations

Interfaces to Live Players

Interface

Runtime Infrastructure (RTI)

Federation Management   Declaration Management

Object Management   Ownership Management

Time Management   Data Distribution Management

The HLA is a standard and does not mandate a specific software implementation